CHAPTER - 6

PALEOENVIRONMENTS

Various paleontological and sedimentological investigations carried out, have led to the deciphering of fairly detailed environments of deposition of the Oligocene strata. In order to analyse the environments in precision, several vertical logs based on various parameters have been prepared for each section. Ultimately, the gross lateral variations of paleoenvironments and paleoecology representing three stratigraphic slices have been interpreted on the basis of compilation of vertical logs.

6.1 VERTICAL VARIATIONS

Vertical variations of microenvironments have been indentified on the basis of integrated vertical logs comprising microfacies, biozones and insoluble residue for each section (Figure 6.1 to 6.4). Such data have been interpreted in terms of detailed environmental logs describing microenvironments in relation to litho and biofacies (Figure 6.5 - 6.8). Finally, such detailed microenvironments have been correlated in terms of gross vertical variations (Figure 6.9 - 6.12).

INTEGRATED DATA

6.1.1 Ratipal Section

Figure 6.1 depicts microfacies and biozones and corresponding insoluble residue in the stratigraphic section for Ratipal area. It is observed that two prominent foraminiferal zones occur in Ramania stage corresponding to shale and silty shale sequence. Likewise,

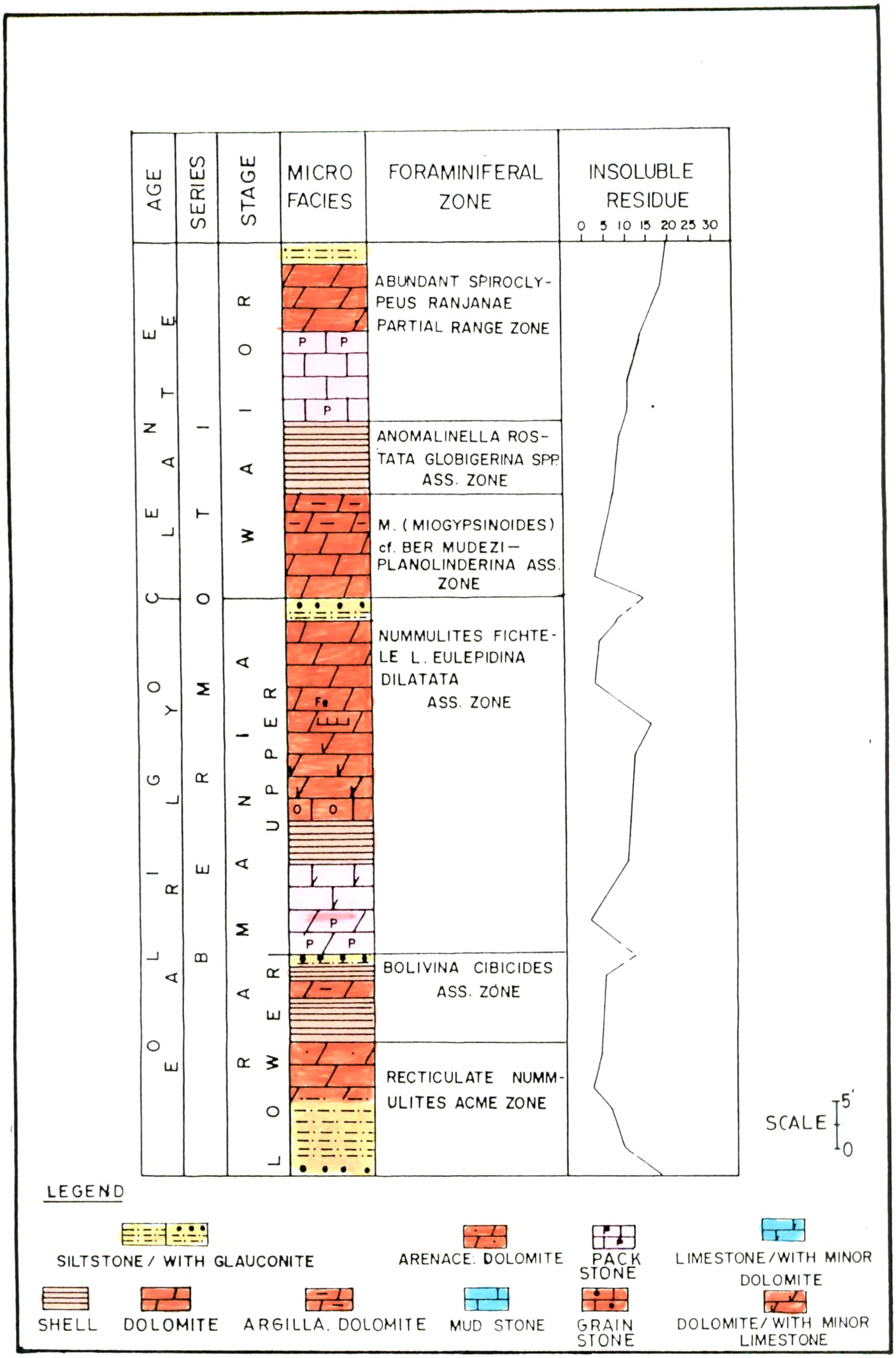

FIG. 6·1, INTEGRATED DATA, RATIPAL SECTION.

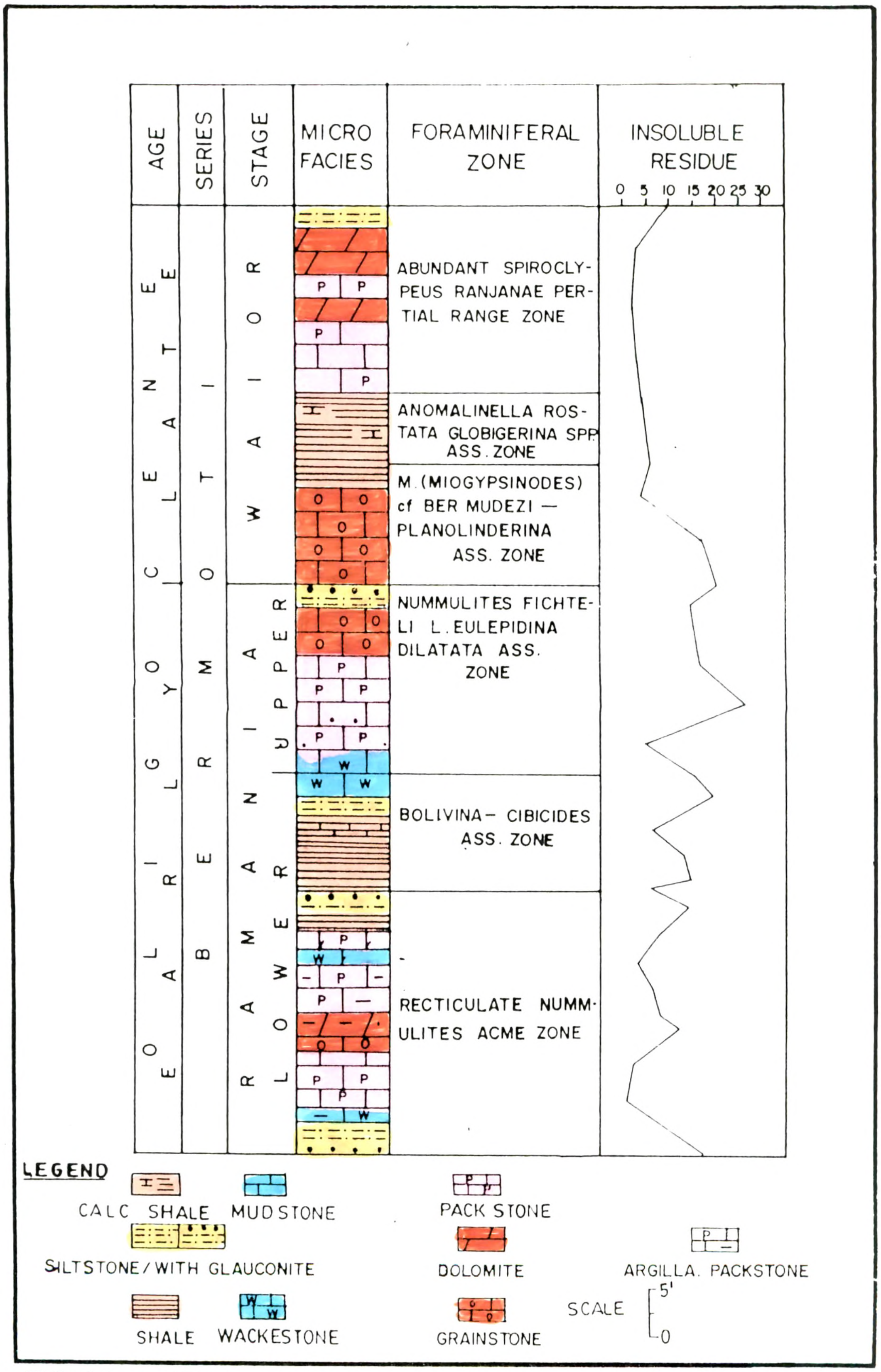

FIG. 6·2, INTEGRATED DATA, BER-MOTI SECTION.

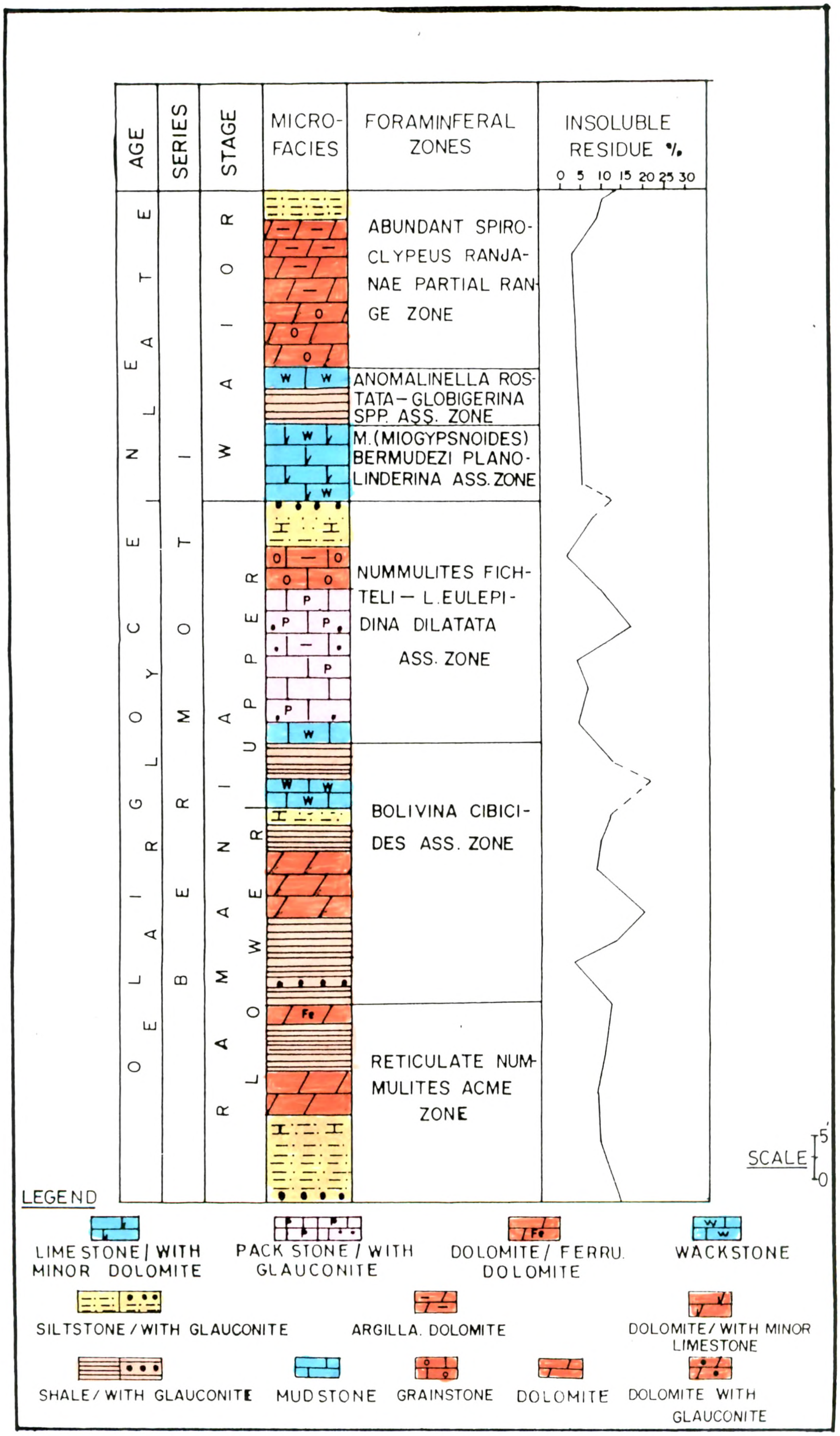

FIG. 6·3, INTEGRATED DATA, BERNANI SECTION.

two coralline limestone zones occur within Ramania stage. Majority of carbonate strata shows secondary dolomatization in Ratipal section. The micro and biofacies with the insoluble residue content show repetitive nature, in turn, indicative of similiar repetitive environmental setting.

6.1.2 Bermoti Section

Four siltstone and three shale horizons along with prominent coralline packstone and grainstone, mudstone-wackestone and dolomite characterise the Bermoti strata (Figure 6.2). The important fossil content comprises Nummulites, Operculina, Lepidocyclina, Miogypsina, Spiroclypeus and many genera of benthic foraminifera. Corals are more common in carbonates, whereas deep-dwelling benthics and planktons in the shale. Nummulites bars commonly occur within argillaceous mudstone/wackestone facies.

6.1.3 Bernani Section

The lower part of Ramania stage is predominated by argillaceous sequence with intervening dolomite bands (Figure 6.3). Nummulites bars are common. The upper Ramania stage indicates thick packstone sequence and good coralline growth. Dolomitic limestone is also common in Waior stage.

6.1.4 Waior Section

The shale and packstone/grainstone facies predominate in the

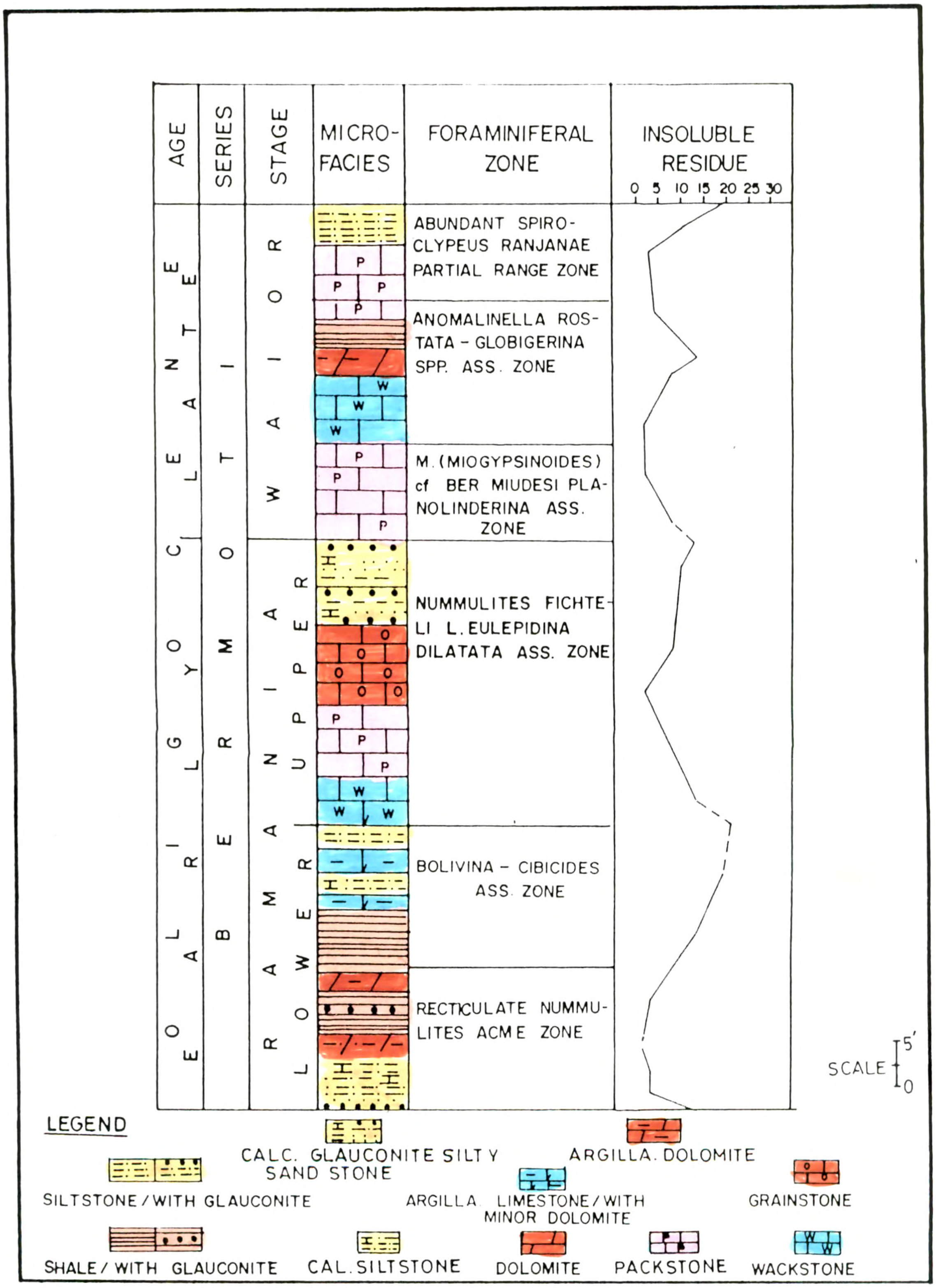

FIG. 6·4, INTEGRATED DATA, WAIOR SECTION.

lower and upper Ramania stage respectively (Figure 6.4). Molluscs are common in the lower Ramania stage.

The carbonate facies also contain Nummulites along with minor coralline growth. Packstone-wackestone facies consisting of Spiroclypeus, and variety of mega fossils like echinoids, oysters are common in the Waior stage.

6.2 MICROENVIRONMENTAL LOGS

6.2.1 Rapital Section

Figure 6.5 indicates detailed variations of microenvironments along the Rapital section. The beginning of the Ramania stage experienced shallow lagoon environments which grades upwards into intertidal and open shelf/platform conditions. This in turn changes to restricted circulation subtidal lagoon and again merges upwards into high energy intertidal deposition as evidenced by grainstone facies and coralline reef development (Plate XI A). However, in this horizon a fair amount of carbonate mud still remained in the packstone/grainstone facies indicating temporary fluctuations in the energy of depositing medium and poor washing. Wilson, (1975), attributes moderate to high energy conditions for such microfacies. The sequence grades upwards into ferruginous, concretionary and peloidal siltstone and claystone band. This obviously suggests shallow, oxidising, regressive environments. This corresponds with the top of Ramania stage.

The Waior stage is characterised by shallow lagoonal, low energy deposition, giving rise to dolomite. Both Irwin (1965) and Selley (1970) assign similar near shore restricted circulation conditions for development of dolomites. A second stage of dolomatization is observed at the top of Waior stage in Ratipal section, after the changing environments from low energy subtidal resulting in the deposition of shaly sequence, below dolomites. The top of the stage is, however, marked by nearshore siltstone bands.

6.2.2 Bermoti Section

Shallow lagoonal to nearshore environments prevailed at the beginning of Ramania stage giving rise to glauconitic siltstone deposits (Figure 6.6.). High content of Nummulites above this sequence indicates open circulation shelf environments. The environments subsequently changed to moderate energy intertidal as evidenced by good coralline growths. There appeared to be a sudden drop in the sea level and minor diastem is interpreted on the basis of ferruginous clay and mudstone band comprising reworked fauna. Second phase of deposition has resulted in a low energy subtidal shelf deposition followed up by high energy intertidal coralline biohermal growths. The base of the section is, marked by development of Nummulites bar (Plate XI B). Luterbacher (1984), suggests high energy environments for Nummulites bar. The top of Ramania stage too, indicates a break in sedimentation as observed in field by reworked, ill preserved and bored fauna as well as ferruginous and gypsous clays.

The Waior stage, indicates open circulation low energy platform facies which developed foraminiferal mudstone / wackestone. This is followed by subtidal shale deposition containing a fair amount of planktons and deep dwelling bentics (Plate XI C). This, in turn changed to shallow, near shore dolomite deposition and ultimately culminated in nearshore unfossiliferous clastic deposits with ferruginous concrections indicative of regressive phase (Plate XI C).

6.2.3 Bernani section

In Bernani section, during the Ramania stage deposition three clear sea level fluctuations could be observed resulting into environmental variations in a vertical section. The base of Ramania is characterised by near shore glauconitic siltstone deposits. (Figure 6.7, Plate XII A). Additionally, minute benthic foraminifera comprising mainly of miliolids and boliviniids are commonly observed. Low energy lagoonal dolomites with abundant Nummulites and Operculina, usually in relic forms, are present. This indicates change of original open circulation to restricted lagoon giving rise to dolomitazation. Near shore marine transitional environment continued further upwards which has resulted into deposits containing reworked fauna and bryozoa. High energy intertidal coralline packstone indicates change to onlap conditions. It further continued giving rise to low energy, subtidal shales (Plate XII B). The shales are overlain by glauconitic siltstone also containing low salinity / brackish water ostracoda. A thick sequence of coralline limestone along with Nummulites bar does indicate high energy intertidal deposits. The reefal limestone is in turn overlain by argillaceous siltstone comprising bryozoa and ostracoda and marks the top of Ramania stage.

The basal shale of Waior stage was deposited under subtidal, low energy environments. High faunal population and their diversity particularly of benthic foraminifera also indicates open circulation. The overlying reefal packstone, shale, dolomite and siltstone represent moderate energy intertidal, low energy subtidal, low energy lagoonal and nearshore deposits respectively.

6.2.4 Waior Section

The vertical sequences for Ramania stage in Waior section is well correlatable with the other three sections in terms of environments of deposition. The basal near shore glauconitic siltstone is correlatable in all the sections (Figure 6.8). This sequence and overlying lagoonal shaly sequence contains miliolids, minute boliviniids and bryozoa. The lagoonal environment continued upwards, where delicate shelled Nummulites predominate (Plate XII C). The logoonal environment changed through time to near shore clastics and in turn further followed by open circulation, high to moderate energy giving rise to reefal packstone, Nummulites bar etc. Low salinty, near shore siltstone and calcareous sand comprising flattened echinoids, may possibly indicate a effect of storm action. A similar phenomenon is also discussed by Wahi et. al. (1991) while describing the environments of Chhasra member, Kutch. The echinoid band marks a top of Ramania stage.

The Waior sedimentation initiated under low energy open circulation shelf environments resulted in a development of argillaceous wackestone comprising high faunal number and diversity of benthic foraminifera. A short lived sea level fluctution has resulted in development of molluscan bank above this. The shallow lagoon conditions followed up by low energy subtidal deposition recognised by presence of deep - dwelling benthonics and few planktons. The tidal flat and intertidal alternations were developed in the upper part of Waior stage. Three highly bio-turbated bands representing tidal flat environment has typically characterised this section. This is overlain by high energy intertidal coupled with prominent current sorting conditions as indicated by very high faunal number and low diversity in Spiroclypeus calcareous siltstone band. Abdel Kirem (1983) also opines similar view for Cretaceous of NE Iraq marked by unfossiliferous ferruginous siltstone with clay pellets.

6.3 GROSS VERTICAL VARIATIONS IN ENVIRONMENTS

The results of the detailed study of the vertical sequences have been grouped into gross environmental megasequences and for this, principles adopted by Canerot et.al. (1986) have been followed.

Figure 6.9 shows vertical paleoenvironmental variations in Ratipal section. The Ramania stage indicates variations from near shore marine at the base through low energy, shallow open shelf

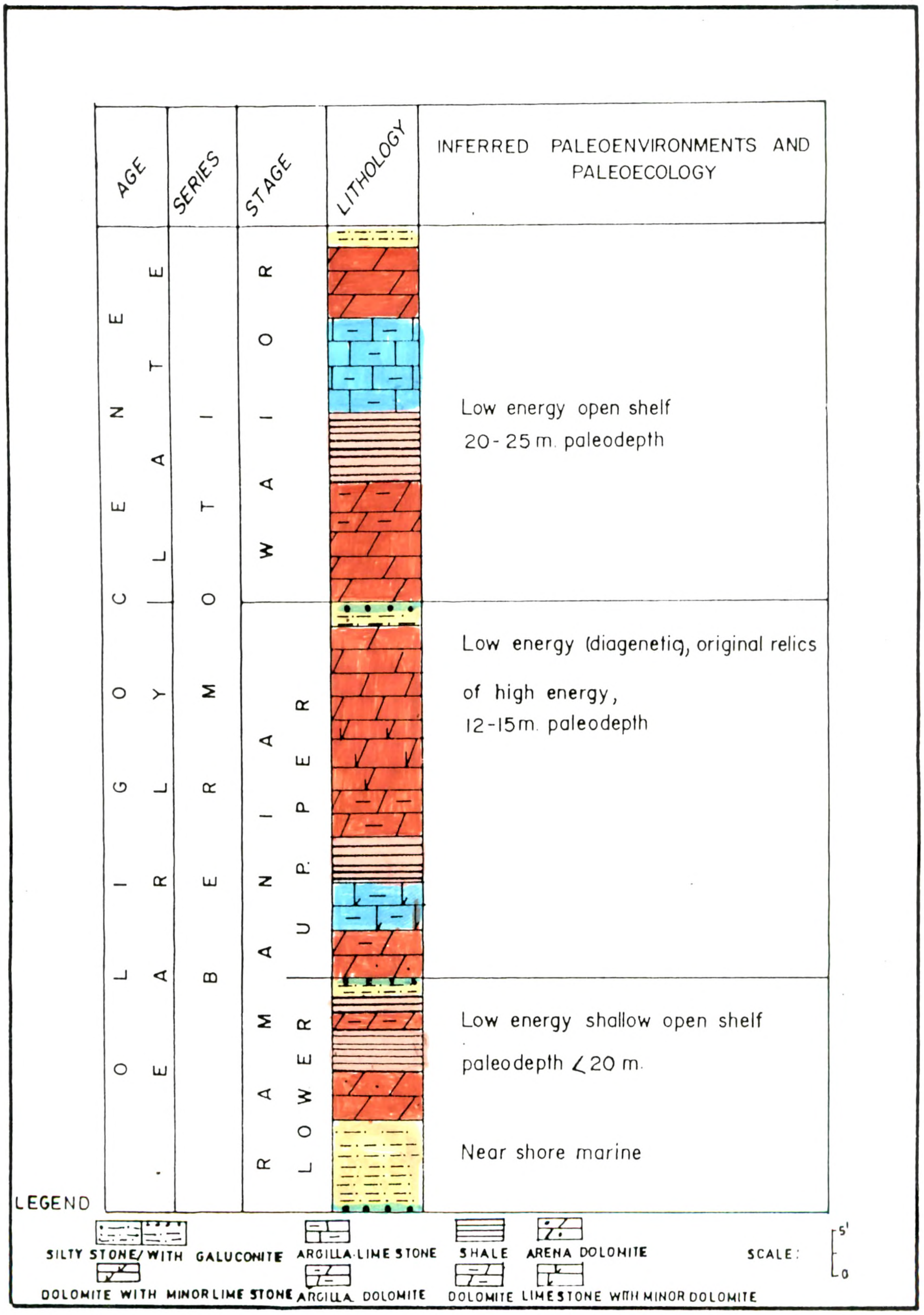

FIG. 6·9 VERTICAL VARIATION OF PALEOENVIRONMENTS
RATIPAL TRAVERSE

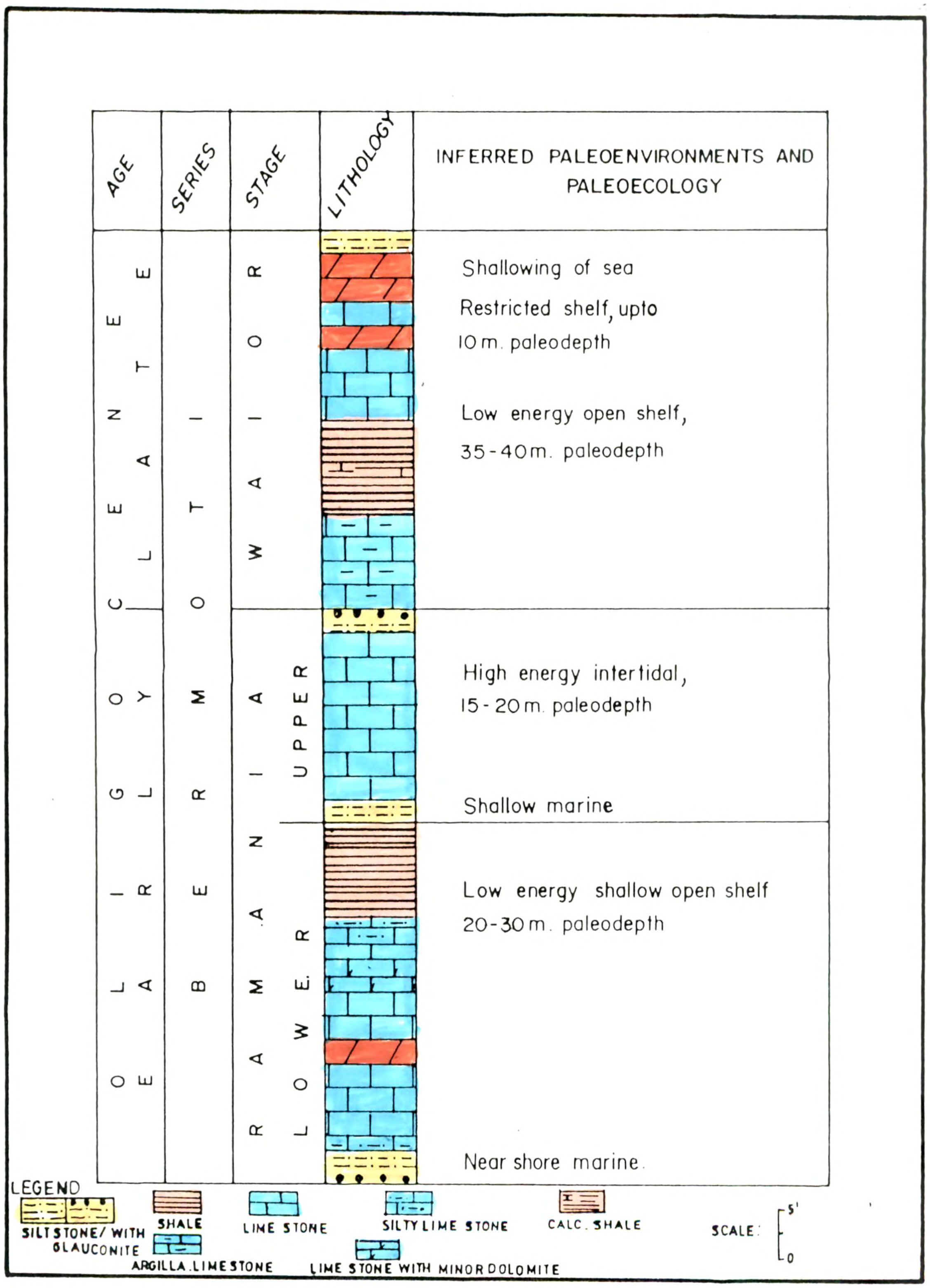

FIG. 6.10 VERTICAL VARIATION OF PALEOENVIRONMENTS BER-MOTI TRAVERSE.

having paleodepths less than 20 metres to low energy dolomitic deposition at the top; the paleodepth usually varying from 10 to 15 metres. Low energy is not indicative of the orginial deposits but represents only environments of dolomitization. The Waior stage indicates low energy open shelf paleoenvironments having bathymetry between 20 to 25 metres.

Likewise, Ramania stage of the Bermoti section (Figure 6.10) also shows variations from nearshore marine at the base through high energy intertidal having 15-20 metres bathymetry towards the top. The overlying Waior stage indicates, low energy open shelf having 30-40 metres bathymetry and shallowed to restricted shelf at the top.

As in the two other sections (Figure 6.11) the Bernani section also indicates variations from near shore marine to low energy open shelf to high energy intertidal environments during Ramania stage deposition. The overlying Waior stage shows low energy open shelf environments with bathymetry ranging from 30 to 10 metres from base to top respectively.

The Ramania stage of Waior section is characterised by low energy open shelf environments in the lower half and high energy intertidal in the upper half, (Figure 6.12). The Waior stage essentially represents low energy shelf lagoonal conditions with varying depths. The paleobathymetry was of the order of 30 metres at the beginning of Waior deposition and only about 5 metres towards the top.

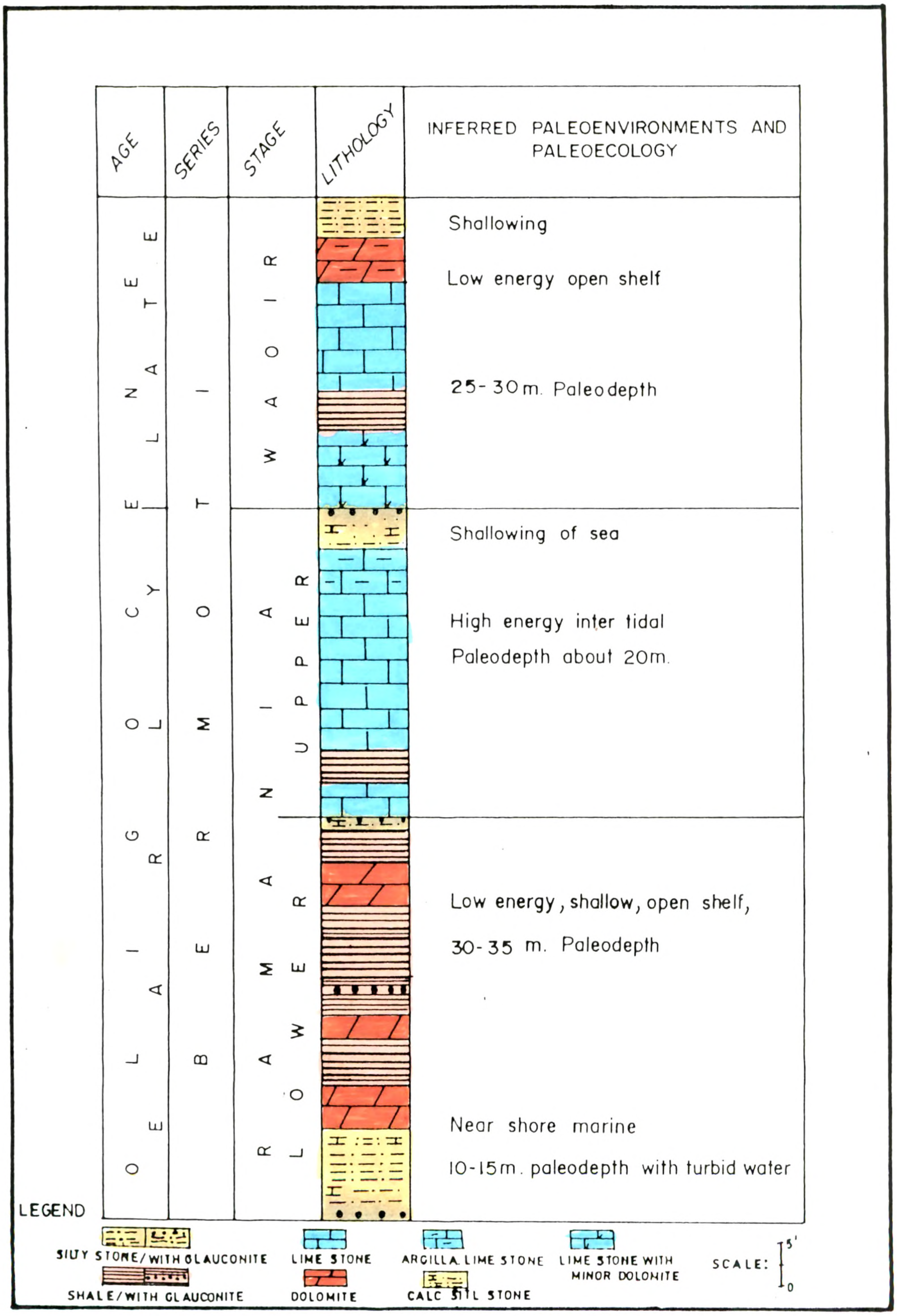

FIG. 6·11 VERTICAL VARIATION OF PALEOENVIRONMENTS BER-NANI TRAVERSE.

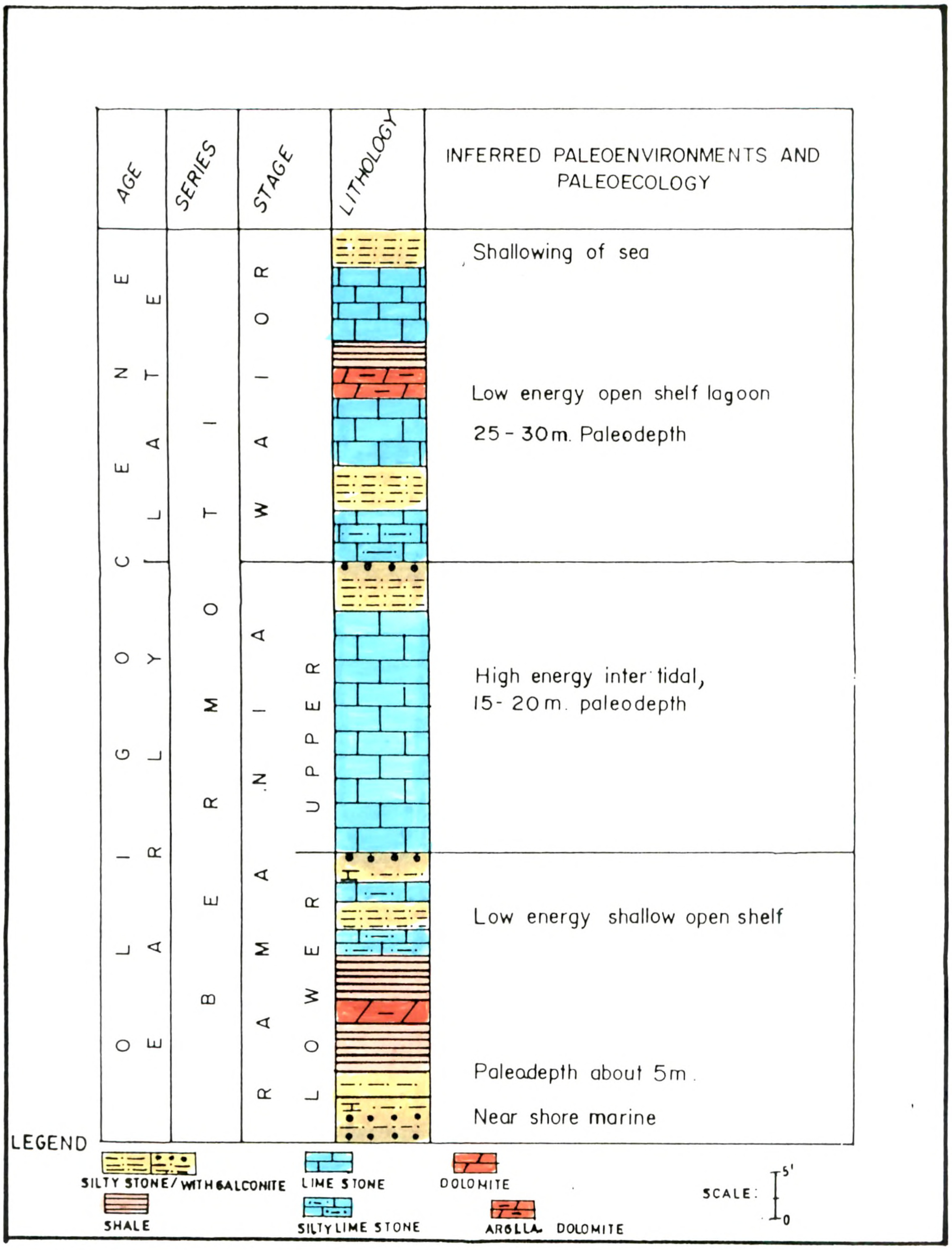

FIG. 6.12, VERTICAL VARIATION OF PALEOENVIRONMENTS WAIOR TRAVERSE.

6.4 AREAL DISTRIBUTION OF PALEOENVIRONMENTS

6.4.1 Paleoecology

Lower Ramania Stage

The paleoecological setting during deposition of Ramnia stage (Figure 6.13) indicates paleobathymetry ranging from about 5 metres in the east near Waior to upto 20 metres in the northwest near Ratipal. The area north of Bermoti experienced maximum depth of deposition ranging between 20 to 30 metres. In the area north of Bermoti it is about 10 to 15 metres. In general, the water was somewhat turbid, partly contaminated by clay / mud. The paleobathymetric interpretations has been adopted on the basis of principles suggested by Murrey (1973).

Upper Ramania Stage

During the upper Ramania sedimentation, the area around Waior and Bernani experienced deepening as compared to lower Ramania (Figure 6.14). In contrast, the western part around Bermoti and Ratipal, experienced shallowing of the sea. The paleobathymetry ranged between 15 to 20 metres around Waior and Bernani, upto 20 metres near Bermoti and between 10 to 15 metres in the Ratipal in the northwest. In general, clear, well oxigenated, warm waters free of clay and mud prevailed during the deposition.

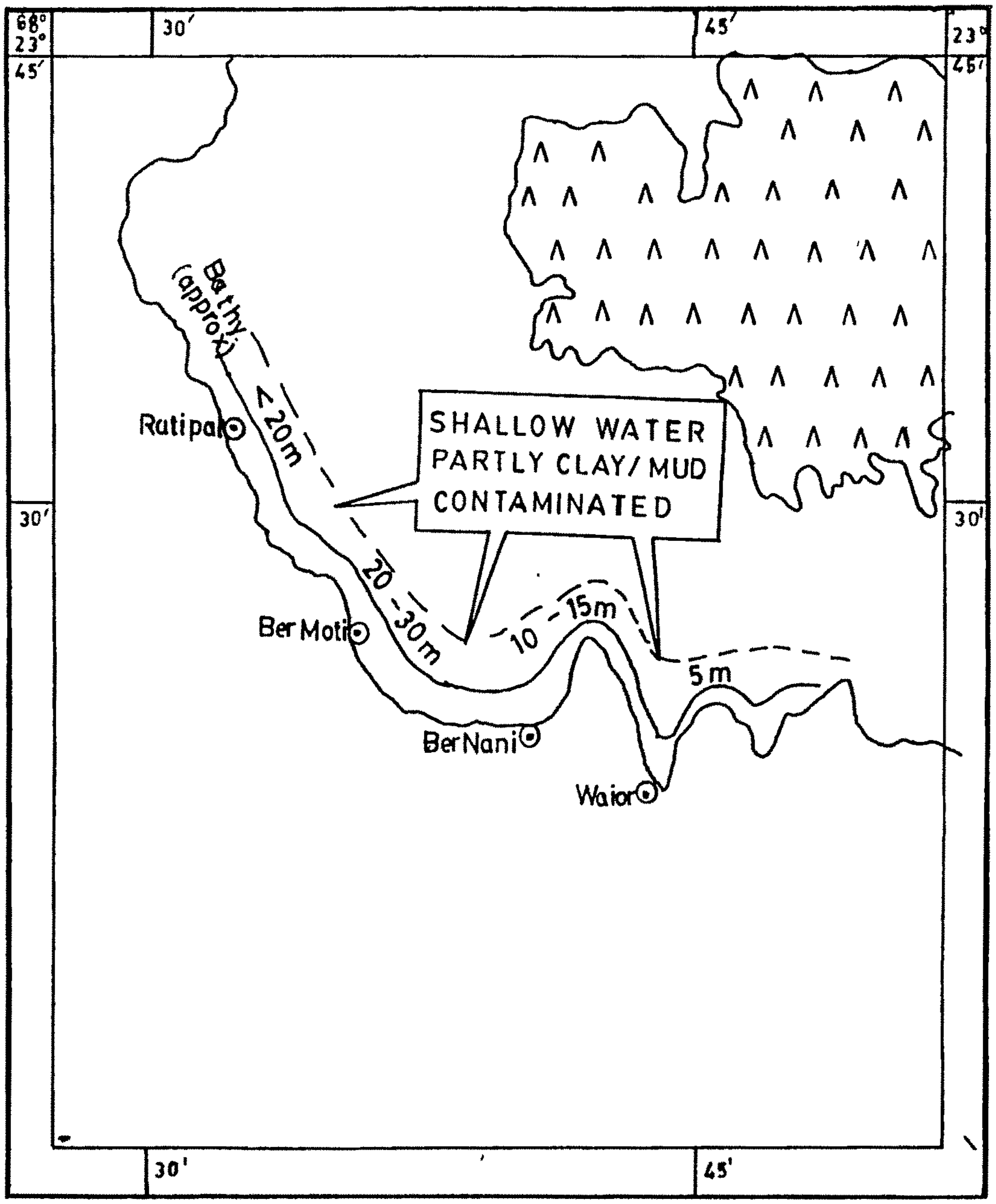

FIG:6·13,, PALEOECOLOGY, LOWER PART OF LOWER RAMANIA STAGE.

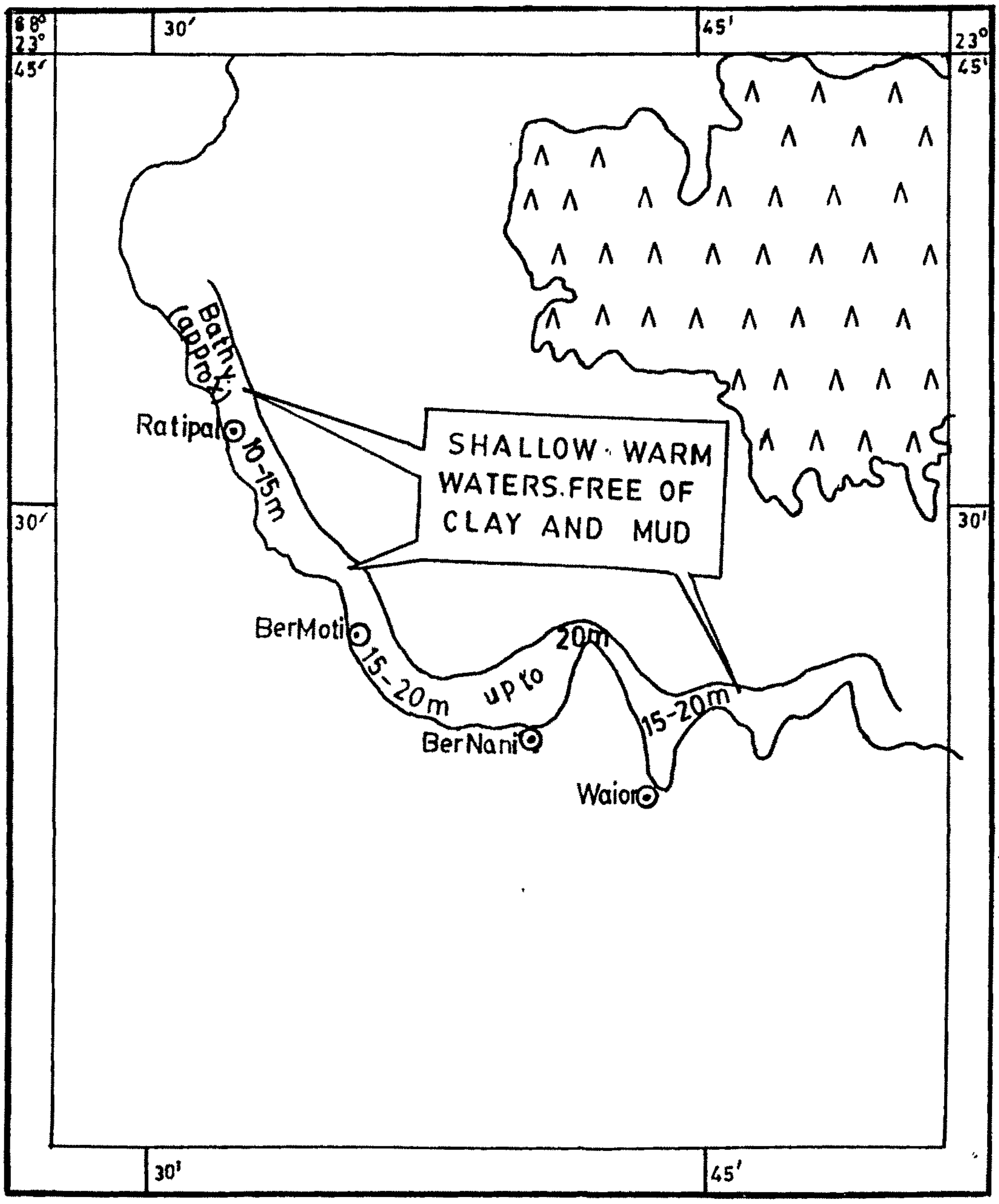

FIG:6·14, PALEOECOLOGY, LOWER PART OF UPPER RAMANIA STAGE.

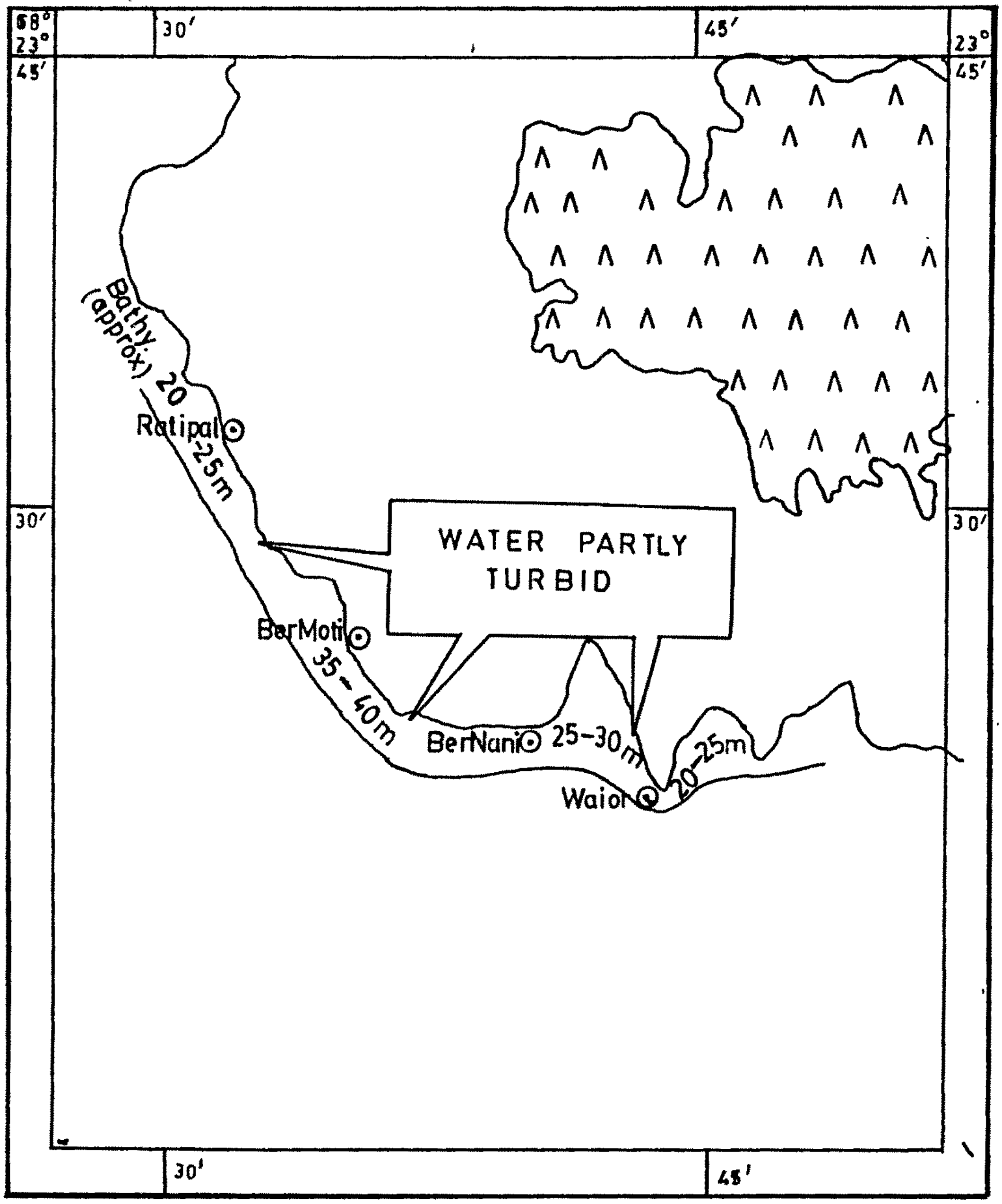

FIG:6·15, PALEOECOGY, LOWER PART OF WAIOR STAGE.

Waior State

The paleobathmetry in most of the area appreciably deepened during the deposition of Waior strata as compared to upper Ramania (Figure 6.15). The area around Bermoti experienced the greatest depth i.e. upto 35 to 40 metres. The eastern part around Bernani and Waior experienced around 25 to 30 metres and 15-20 metres depth respectively. Upto 20-25 metres bathymetry prevailed around Ratipal area. In general, the sediments were deposited under partly turbid water environments.

6.5 PALEOENVIRONMENTS

Lower Ramania Stage

Figure 6.16 refers to the areal distribution of environments during the deposition of lower Ramania stage sediments.

Three linear and arcuate environmental belts are indentified in the area namely, the near shore marine, low energy shallow open shelf and the high energy intertidal. The high energy intertidal belt is interpreted to be present in the south-western part. The peleostrand line was likely to be present further northeast of the near shore marine belt. The low energy carbonate mudstone-wackestone facies are representative of open circulation shelf lagoon environments (Wilson, 1975). The absence of evaporites and supratidal deposits in the area and also the presence of basal glauconitic siltstone bands suggests that the sedimentation took

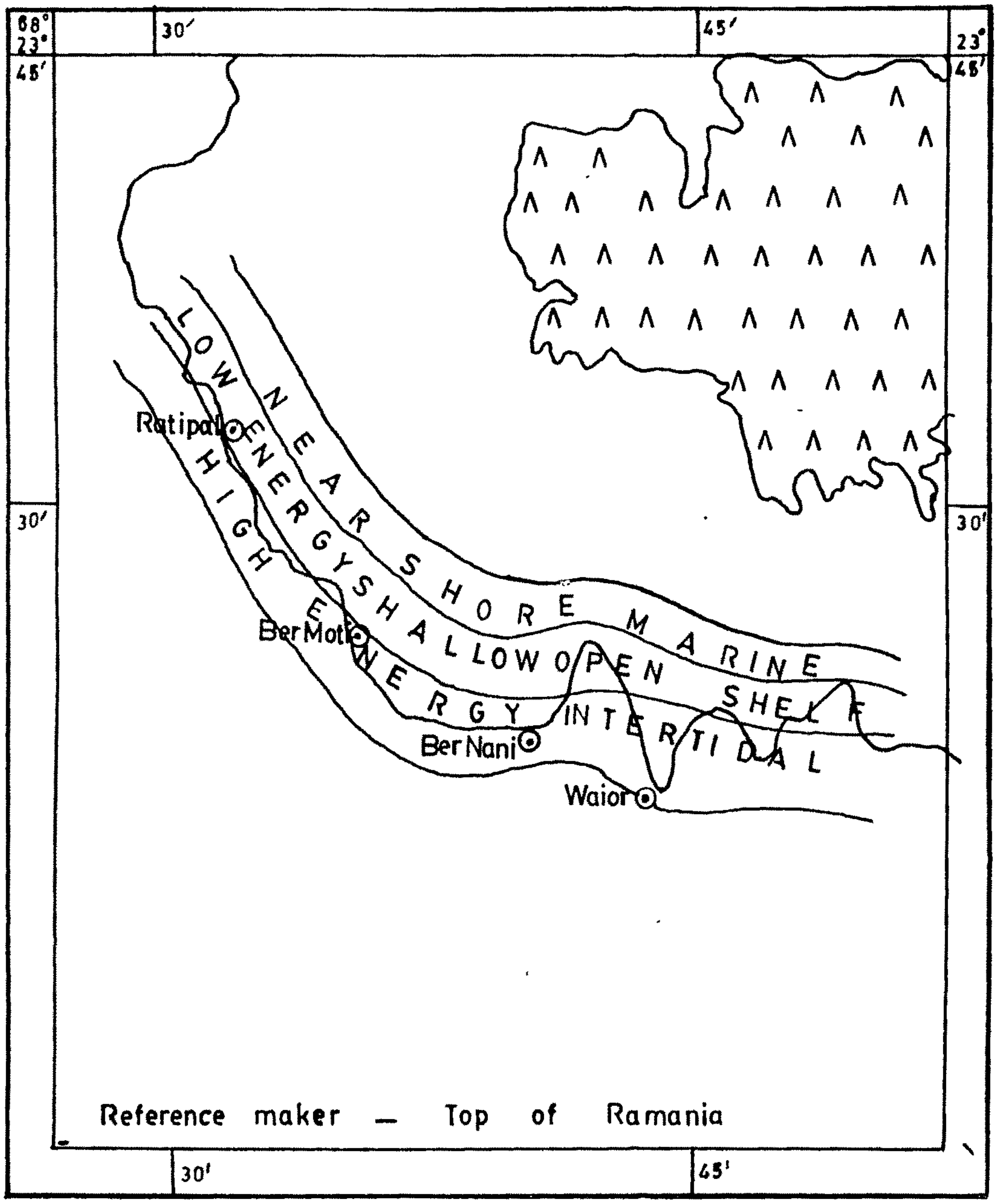

FIG: 6·16, PALEOENVIORNMENTS, LOWER RAMANIA STAGE.

place in a pericontinetal shelf sea rather than an epicontinental one. Heckel, (1972) suggests similar setting for a continental shelf directly connected with deep oceanic basin.

Upper Ramania Stage

Three environmental belts i.e. low energy shelf, high energy intertidal and low energy subtidal have been identified for the sediments deposited during upper Ramania stage (Figure 6.17).

There is a slight shift of the environmental belts towards north-east indicating as onlap conditions. The high energy intertidal environment is obviously related to wave action and may, thus, represents a mini "Y" zone of Irwin, (1965), and Selly (1970); Coogan, (1969), also suggests similar setting for the biohermal and oolitic deposits. The possible occurrence of low energy subtidal belt further south-west has been inferred.

Waior Stage

Most of the outcropping area indicates bioclastic wackestone and mudstone facies in turn indicating presence of both fauna and large amount of carbonate mud (Figure 6.18). This obviously suggests low energy, open shelf conditions. The glauconite as a authigenic mineral usually indicates either shallow or deep marine environments (Odum et. al. 1960 cf. Deshpande et. al 1991). In the present case, however, it is inferred that glauconite has been

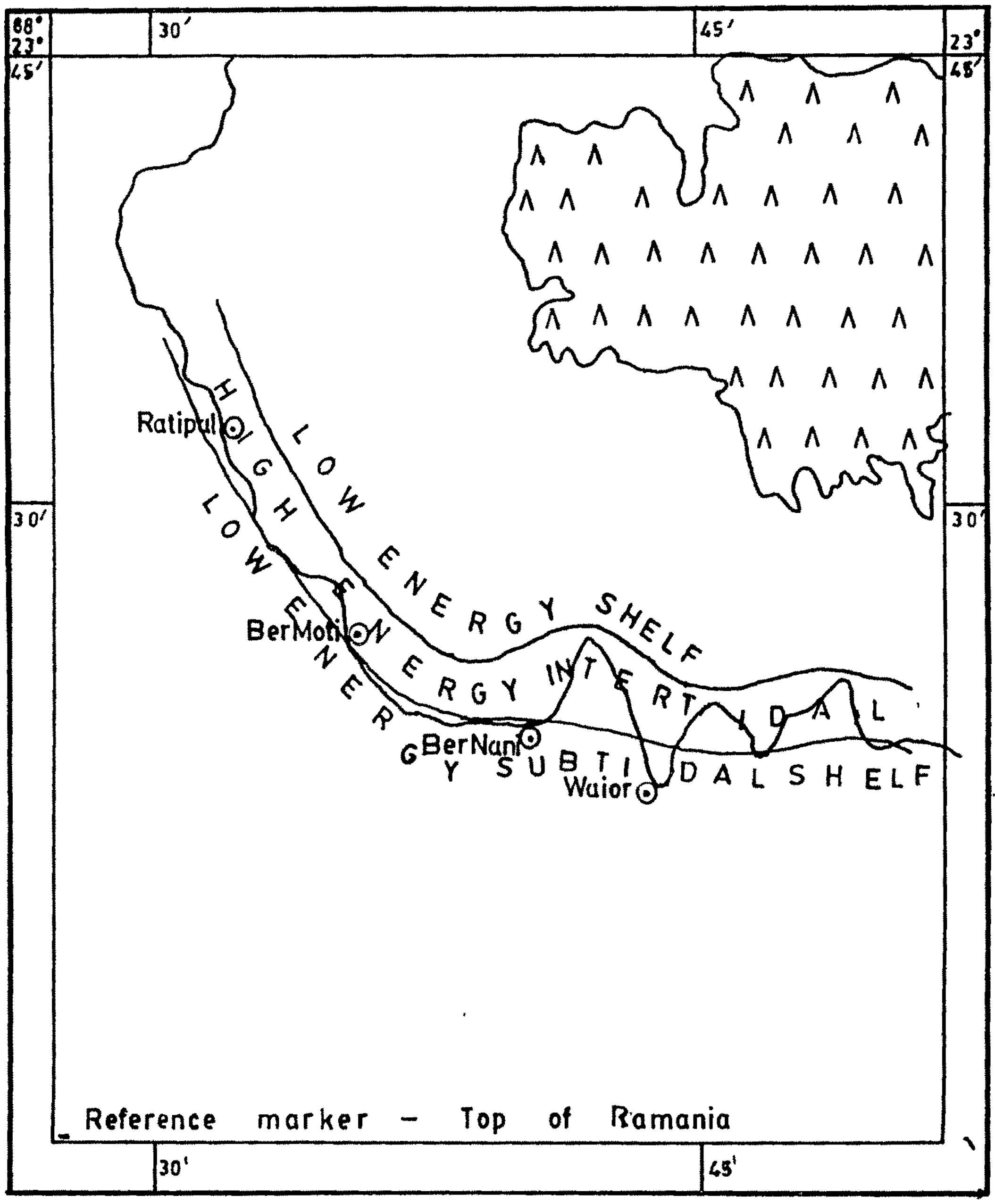

FIG : 6·17, PALEOENVIORNMENTS, UPPER RAMANIA STAGE.

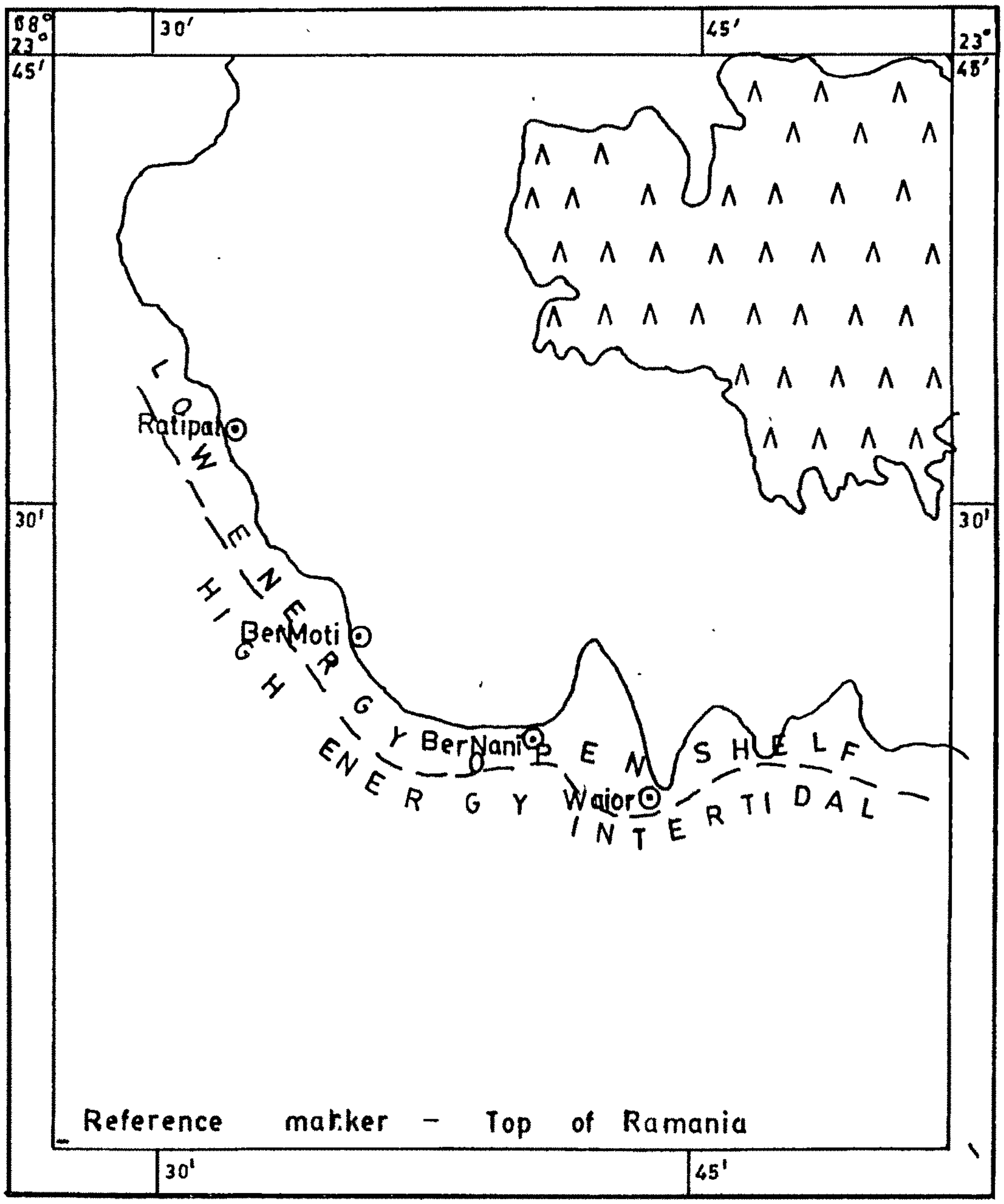

FIG: 6·18, PALEOENVIORNMENTS, WAIOR STAGE.

generated necessarily in the shallow marine environments. The highly bioturbated and carbonate bands also suggest deposition only under well oxigenated tidal flat environments with abundant supply of carbonate mud and growth of biota. Though, the low energy shallow shelf conditions prevailed during Waior sedimentation in the outcropping area, it is most likely that high energy, intertidal conditions should have existed in the area further southwest.